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COLOR VARIATION IN THE SPOTTED GROUND SQUIRRELS OF THE TULAROSA BASIN, NEW MEXICO

BY W. FRANK BLAIR

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INTRODUCTION

NINE adult spotted ground squirrels (*Citellus spilosoma major*) were trapped on the gray soil of the mesquite association near Alamogordo, New Mexico, in the spring of 1940. A like number was obtained on the White Sands, which comprise about 270 square miles of nearly pure gypsum dunes some fifteen miles distant. The species is widely distributed in the Tularosa basin and occurs in considerable numbers at the two trapping localities. The ground squirrels were kept in captivity at the Laboratory of Vertebrate Genetics in Ann Arbor until mid-July, 1940, when they were prepared as flat skins. One female from the White Sands was pregnant when caught and gave birth to six young on May 14. These were raised to maturity and prepared as flat skins on November 1, 1940. Round skins were prepared in the field of four specimens that were trapped at the Alamogordo station in October, 1938. Thus, there are available for comparison fifteen specimens from the White Sands and thirteen specimens from Alamogordo.

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TABLE I

COLOR OF SPOTTED GROUND SQUIRRELS (*Citellus spilosoma major*) AND SOILS FROM NEAR ALAMOGORDO, AND FROM THE WHITE SANDS, NEW MEXICO

Means, extremes, and standard errors of tint photometer readings, in per cent

	Locality	No.	Color Screens		
			Red	Green	Blue-Violet
Soil	Alamogordo	......	22.80 (21–24)	16.20 (16–17)	12.60 (11–14)
Soil	White Sands	......	71.00 (69–76)	63.60 (61–65)	60.60 (57–63)
Citellus s. major	Alamogordo	13	21.54 (19–28) ± 0.80	14.54 (11–20) ± 0.61	11.31 (7–17) ± 0.66
Citellus s. major	White Sands	15	25.20 (21–30) ± 0.78	17.60 (14–26) ± 0.84	14.13 (10–21) ± 0.72

VARIATION IN PELAGE COLOR

The ground color of the dorsal pelage in the nape region of the ground squirrels was measured by means of the Ives tint photometer, with the method described by Dice (1932: 19). The readings were made on the nape because, there, few white spots interfere with the measurement of the ground color. Tint photometer readings also were made of soil from the White Sands and from the Alamogordo station. The measurements of pelage color and of soil color are given in Table I. Three color screens, red, green, and blue-violet, have been used in making the readings. The readings are the percentage of light of that color reflected from the specimen as compared with the amount of light reflected from a white block of magnesium carbonate, which is taken as 100 per cent.

The White Sands group of specimens averages significantly higher, that is, paler, than the specimens of the Alamogordo stock in the readings for all of the color screens. For red, the difference in means for the two stocks is 3.66 ± 1.12 tint photometer units. For green the difference is 3.06 ± 1.04, and for blue-violet it is 2.82 ± 0.98.

The White Sands, which are nearly pure gypsum and when dry appear almost white to the human eye, have very much higher tint photometer readings for all of the color screens than does the soil from the Alamogordo station (Table I). Therefore, the spotted ground squirrels living on very light colored soil, represented by the White Sands stock, tend to be lighter than those living on relatively dark soil, represented by the Alamogordo stock, although those on the light soil are not nearly so light as the soil on which they occur.

VARIATION IN DISTINCTNESS AND SIZE OF WHITE SPOTS

The length and distinctness of the white spots of spotted ground squirrels are controlled largely by the width of the white band in the hairs making up the spots. Since the white-banded hairs are closely grouped, and since all of the hairs lie almost flat on the body, the longest white bands result in the longest, most distinct white spots. The width of the white band was measured on hairs from the rump of the fifteen flat skins from the White Sands and on the nine flat skins from Alamogordo. No hairs were taken from the four round skins from Alamogordo, as I did not wish to damage them. The measurements were made with dial calipers under a dissecting microscope. The average width of the white band for individuals varied from 1.10 to 1.88 mm. in the Alamogordo stock, and from 1.05 to 2.58 mm. in the White Sands stock. The average width of the white band for all of the hairs measured in the Alamogordo stock was 1.37 mm., and in the White Sands stock it was 1.73 mm.

An analysis of the variance in the width of the white band in the ground squirrels from the two stations has been made (see Table II). With this method it will be determined (1) whether or not animals from the two sta-

TABLE II

Analysis of Variance in Width of White Band on Hairs from Rump Spots of Spotted Ground Squirrels from Alamogordo and the White Sands, New Mexico

Source of Variation	D/F	Sum of Squares	Mean Square	F Value
Between stocks	1	8.84	8.84	5.49*
Within stocks				
Within Alamogordo				
Between individuals	8	6.76	0.84	8.40†
Within individuals	126	13.04	0.10	
Within White Sands				
Between individuals	14	28.71	2.05	13.67†
Within individuals	135	20.46	0.15	
Error for testing significance of stock difference	(22)	(35.47)	(1.61)	
Total	284	77.81		

Test of significance of difference between stock variances, F = 2.05/0.84 = 2.44.

* Denotes ''significant'' F value (P <.05).
† Denotes ''highly significant'' F value (P <.01).

tions differ significantly in the width of this band, (2) whether or not significant variation exists between individuals at each station, and (3) whether or not the amount of variability in the width of the white band differs significantly between the two stations.

The difference between stocks in width of the white band is considered significant because the F value for the comparison between stock variance and individual variance (see Table II) falls between the 5 per cent and the 1 per cent points. The chance that the F value would be exceeded in random sampling from a homogeneous population lies between one in twenty (5 per cent point) and one in one hundred (1 per cent point). The variation between individuals at both stations is highly significant, for in both cases the F value for the comparison of inter-individual and intra-individual variance greatly exceeds the F value for the 1 per cent point. The amount of variability does not differ significantly between the two stations, for the F value for the comparison of inter-individual variance in the two stocks falls below the 5 per cent point.

From the analysis of variance in the width of the white band one learns, therefore, that the variation between individuals is highly significant at both stations. There is no significant difference between the two stocks in the amount of variability. The two stocks differ significantly in the width of the white band. The White Sands stock has the greatest mean width of this band, 1.73 mm., compared with 1.37 mm. in the Alamogordo stock. Therefore, it is evident that the width of the white band is significantly greater in the White Sands than in the Alamogordo ground squirrels. Since the width of the white band controls the distinctness and length of the dorsal white spots, it follows that the white spots are significantly longer and more distinct in the White Sands than in the Alamogordo stock.

ECOLOGICAL TRENDS IN THE GROUND SQUIRREL POPULATIONS OF THE TULAROSA BASIN

That the spotted ground squirrels living on the White Sands are paler and have longer, more distinct white spots than do those living on the relatively dark soil near Alamogordo presumably indicates an ecological trend such as has been pointed out in numerous species of mammals (see Dice and Blossom, 1937: 114).

The occurrence of these opposite ecological types close together raises interesting questions concerning the evolution of local races. The Alamogordo station is only fifteen miles from the edge of the White Sands, where the White Sands stock was trapped. The spotted ground squirrel occurs, although somewhat sparsely, in the atriplex association that lies between the mesquite association at Alamogordo and the White Sands. Benson (1933: 23) recorded the species from just north of the White Sands. This species probably is present also all around the White Sands, on soils that, like the Alamogordo soil, are much darker than the White Sands soil. This being the case, it follows that there is the possibility of free interchange of genes between the White Sands population of ground squirrels and the populations inhabiting the surrounding areas of relatively dark soil. With this free interchange of genes the differences between the White Sands population and the contiguous darker colored population presumably could not be maintained without the operation of some sort of selection. Without selection it is to be expected that the characters of the White Sands population would be swamped by the inflow of characters from the surrounding, relatively dark population.

The selection toward pale animals with large, distinct spots on the White Sands must be rather intensive, and it must be in operation at the present time. No physical isolation, so far as is known, prevents the interchange of genes between the White Sands and surrounding populations. Therefore, the rate of selection on the White Sands must be greater than the swamping effect resulting from the inflow of characters from the surrounding, darker colored population.

SUMMARY

The stock of spotted ground squirrels (*Citellus spilosoma major*) from the White Sands, New Mexico, is paler and has larger, more distinct white spots than another population living on relatively dark soil near Alamogordo, some fifteen miles distant. Because spotted ground squirrels inhabit the area intervening between the two stations, there is the possibility of free interchange of genes between the two populations. Selection toward pale color and distinct white spots evidently must be occurring now on the White Sands, otherwise the pale color and large spots of the White Sands population would probably be swamped by the influx of other genes from the populations occupying the surrounding, relatively dark soil, where the trend is toward dark animals with indistinct white spots.

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